LEWIS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF: GP

OCT 18 1973

TO: KSI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U.S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code KSI, the attached NASA-owned U.S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No.	: 3,762,918
Government or Corporate Employee	: Government
Supplementary Corporate Source (if applicable)	:
NASA Patent Case No.	: LEW-10431-1

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:
Yes [ ] No [X]

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of column No. 1 of the Specification, following the words ". . . with respect to an invention of . . ."

Elizabeth A. Carter

Elizabeth A. Carter
Enclosure
Copy of Patent cited above

NASA-HQ

United States Patent [19]

Dreshfield et al.

[11] **3,762,918**

[45] **Oct. 2, 1973**

[54] **COBALT-BASE ALLOY**

[75] Inventors: **Robert L. Dreshfield**, Middleburg Heights, Ohio; **Gary D. Sandrock**, Ringwood, N.J.; **John C. Freche**, Fairview Park, Ohio

[73] Assignee: **The United States of America as represented by the Administrator of the National Aeronautics and Space Administration**, Washington, D.C.

[22] Filed: **Jan. 26, 1972**

[21] Appl. No.: **221,093**

[52] **U.S. Cl.** **75/170,** 75/171

[51] **Int. Cl.** **C22c 19/00**

[58] **Field of Search** 75/170, 171

[56] **References Cited**

UNITED STATES PATENTS

3,276,865	10/1966	Freche et al.	75/170
3,383,205	5/1968	Sims et al.	75/171
3,403,021	9/1968	Wlodek	75/171
2,974,037	3/1961	Thielemann	75/171
3,582,320	6/1971	Herchenroeder	75/171
3,432,294	3/1969	Wheaton	75/171

Primary Examiner—G. T. Ozaki
Attorney—N. T. Musial et al.

[57] **ABSTRACT**

Cobalt-tungsten alloys containing titanium, zirconium, carbon, chromium, rhenium, iron and nickel in preferred weight percentage ranges have superior strengths at elevated temperatures.

5 Claims, No Drawings

COBALT-BASE ALLOY

ORIGIN OF THE INVENTION

The invention described herein was made by employees of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

This invention is concerned with microstructurally stable, high-strength cobalt base alloys for use at elevated temperatures. The invention is particularly directed to cobalt-tungsten alloys for components in advanced gas turbines.

Nickel base alloys have been proposed for the hot components of gas turbine engines. However, many of the materials drop off sharply in strength above 1900° to 2000° F. Higher turbine inlet temperatures above 2000° F are necessary to meet the increased performance requirements of advanced gas turbines. This creates a need for materials that have improved strength at high temperatures.

While high temperature strength is of primary importance in gas turbines, ductility is also important at all temperatures to the maximum use temperature. The ductility must not be substantially decreased upon long time exposure at any temperature. A cobalt base alloy described in U.S. Pat. No. 3,276,865 has been considered for use in advanced gas turbines. However, this alloy is subject to embrittlement upon exposure to temperatures between 1200° F and 1600° F.

SUMMARY OF THE INVENTION

These requirements have been met by the cobalt-tungsten alloys of the present invention. The nominal compositions, in weight percentages, of these alloys are 10–25 percent tungsten, .5–1 percent titanium, .25–5 percent zirconium, .1–1 percent carbon, 0–5 percent chromium, 0–3 percent rhenium, 1–10 percent iron, 1–10 percent nickel, and the balance cobalt.

OBJECTS OF THE INVENTION

It is, therefore, an object of the present invention to provide cobalt-tungsten alloys having improved strengths at elevated temperatures up to 2125° F.

Another object of the invention is to provide microstructurally stable alloys having properties pertinent to long time engine applications.

A further object of the invention is to provide a cobalt-tungsten alloy having adequate ductility at all temperatures to the maximum use temperature wherein the ductility is not substantially decreased upon long time exposure at any temperature.

These and other objects of the invention will be apparent from the specification that follows.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention is embodied in alloys having the following composition range, the amount of each alloying element being listed as a percentage by weight:

	Percent
Tungsten	From about 10 to about 25
Titanium	From about 0.5 to about 1
Zirconium	From about 0.25 to about 0.5
Carbon	From about 0.1 to about 1
Chromium	From about 0 to about 5
Rhenium	From about 0 to about 3
Iron	From about 1 to about 10
Nickel	From about 1 to about 10
Cobalt	Balance

A preferred embodiment of the invention includes alloys having the following nominal composition range in weight percent:

	Percent
Tungsten	From 15 to 20
Titanium	From 0.5 to 1.0
Zirconium	From 0.25 to 0.5
Carbon	From 0.4 to 0.6
Chromium	From 1 to 3
Rhenium	From 2 to 3
Iron	From 4 to 6
Nickel	From 1 to 7.5
Cobalt	Balance

The alloys are prepared by conventional melting methods used for the preparation of either nickel-base or cobalt-base superalloys. Vacuum induction melting and investment castings are preferred for preparing cast parts.

Specimens of several known cobalt alloys and preferred compositions of the present invention were tested. A comparison of some mechanical properties of these specimens is shown in Table 1.

TABLE I

Alloy	Average Stress Rupture Life In Helium, Hours			Average room temp. Elongation after %	
	2125°F 8,000 lb/in²	4,000 lb/in²	2000°F 10,000 lb/in²	192 hrs 1600°F	500 hrs 1400°F
VM 103	133	>2000	157	0.5	
VM 105	97			1.4	
VM 106	52		156.0	2.0	1.0
VM 107	74			1.2	
VM 108	49	>2000	170		3.0
VM 109	73		164.2		2.0

These test specimens were prepared by vacuum induction melting in stabilized zirconia crucibles. Before each melt was poured, the chamber was backfilled to 300 torr of argon. The pour temperature was determined by an optical pyrometer to be 3100° F. Zircon shell molds imbedded in fire-clay grog and held at 1600° F by a resistance mold heater were used.

Each casting consisted of a cluster of tensile test bars. After casting, the molds were allowed to remain in the vacuum chamber for 15 minutes. They were then removed and permitted to cool to room temperature in about 6 hours before knock out and cutoff. Before testing all specimens were vapor-blasted and inspected by radiographic and fluorescent penetrant techniques.

An alloy described in U.S. Pat. No. 3,276,865 was vacuum melted and designated as VM 103. The nominal compositions of VM 103 and the other test specimens in weight percents are listed in Table II.

TABLE II

Alloy	Co	W	Ti	Zr	Fe	Re	Ni	Cr	C
VM 103	Bal	25.0	1.0	0.5	0	0	0	3.0	0.4
VM 105	Bal	20.0	1.0	0.5	5.0	3.0	0	3.0	0.5
VM 106	Bal	17.5	0.75	0.37	5.0	3.0	1.0	3.0	0.5
VM 107	Bal	20.0	1.0	0.5	5.0	3.0	0	3.0	0.6
VM 108	Bal	17.5	0.75	0.37	5.0	3.0	5.0		0.5
VM 109	Bal	17.5	0.75	0.37	5.0	3.0	7.5	3.0	0.5

The incipient melting temperature of VM 108, one of the preferred alloys, is between 2475° F and 2500° F.

This is 100° F higher than that of the highest melting point cast nickel base alloys. This is desirable for potential stator vane applications of advanced engines. These stator vanes must often withstand localized temperatures of 200° F or more higher than the average gas temperatures because of the uneven combustion gas profiles.

While several preferred alloys have been described, various modifications may be made to the alloy compositions without departing from the spirit of the invention or the scope of the subjoined claims. It is contemplated that the average electron vacancy concentration is controlled by suitable alloying adjustments to prevent formation of the intermetallic compound Co_3W which embrittles these alloys if it forms during exposure to temperatures between 1200° F and 1600° F.

What is claimed is:

1. A cobalt-tungsten alloy consisting essentially of in weight percents from 10 percent to 25 percent tungsten, from 0.5 percent to 1 percent titanium, from 0.1 percent to 1 percent carbon, from .25 percent to 0.5 percent zirconium, from 0 percent to 5 percent chromium, from 0 percent to 3 percent rhenium, from 1 percent to 10 percent iron, from 1 percent to 10 percent nickel, and the balance cobalt.

2. A cobalt-tungsten alloy as claimed in claim 1 consisting essentially of in weight percents from 15 percent

to 20 percent tungsten, from 0.5 percent to 1 percent titanium, from 0.4 percent to 0.6 percent carbon, from 0.25 percent to 0.5 percent zirconium, from 1 percent to 3 percent chromium, from 2 percent to 3 percent rhenium, from 4 percent to 6 percent iron, from 1 percent to 7.5 percent nickel, and the balance cobalt.

3. A cobalt-tungsten alloy as claimed in claim 1 consisting essentially of in weight percents from 17.5 percent to 20 percent tungsten, from 0.75 percent to 1 percent titanium, .5 percent carbon, from 0.37 percent to 0.5 percent zirconium, 3 percent chromium, 3 percent rhenium, 5 percent iron, from 1 percent to 7.5 percent nickel, and the balance cobalt.

4. A cobalt-tungsten alloy as claimed in claim 1 consisting essentially of in weight percents 17.5 percent tungsten, 0.75 percent titanium, 0.5 percent carbon, 0.37 percent zirconium, 3.0 percent chromium, 3 percent rhenium, 5 percent iron, from 5 percent to 7.5 percent nickel, and the balance cobalt.

5. A cobalt-tungsten alloy as claimed in claim 1 consisting essentially of in weight percents 17.5 percent tungsten, 0.75 percent titanium, 0.5 percent carbon, 0.37 percent zirconium, 3.0 percent chromium, 3 percent rhenium, 5 percent iron, 5 percent nickel, and the balance cobalt.

* * * * *